

AD-A243 789



2

NAVAL POSTGRADUATE SCHOOL Monterey, California



DTIC
ELECTE
DEC 31 1991
S D

THESIS

EVALUATION AND SELECTION OF A
TELECOMMUNICATION SYSTEM AT THE
NAVAL POSTGRADUATE SCHOOL BOQ

by

Joseph Robert Stone

March 1991

Thesis Advisor:

Myung W. Suh

Approved for public release; distribution is unlimited

91-19137



91 1227 009

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			Approved for public release; distribution is unlimited		
4. PERFORMING ORGANIZATION REPORT NUMBER(S)			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION		
Naval Postgraduate School		AS	Naval Postgraduate School		
6c. ADDRESS (City, State, and ZIP Code)			7b. ADDRESS (City, State, and ZIP Code)		
Monterey, CA 93943-5000			Monterey, CA 93943-5000		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS			
		PROGRAM ELEMENT NO	PROJECT NO	TASK NO	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) EVALUATION AND SELECTION OF A TELECOMMUNICATION SYSTEM AT THE NAVAL POSTGRADUATE SCHOOL BOQ					
12. PERSONAL AUTHOR(S) STONE, Joseph Robert					
13a. TYPE OF REPORT		13b. TIME COVERED		14. DATE OF REPORT (Year, Month, Day)	
Master's Thesis		FROM _____ TO _____		1991 March	
15. PAGE COUNT 83					
16. SUPPLEMENTARY NOTATION The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the US Government.					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP	Telecommunication System; RFP; Evaluation and Selection		
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
Acquiring telecommunication equipment and services requires a business approach in developing requirements and translating them into an RFP. The purpose of this thesis is to demonstrate the actual specification for a Digital Private Branch Exchange (DPBX) and Voice Response System and the review of Request for Proposals (RFP) in order to select the most cost effective proposal. The approach used towards evaluating vendor proposals consists of Life Cycle Analysis, Net Present Value, and Total System Effectiveness models.					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT			21. ABSTRACT SECURITY CLASSIFICATION		
<input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL			22b. TELEPHONE (Include Area Code)		22c. OFFICE SYMBOL
SUH, Myung W.			408-646-2637		AS/Su

DD Form 1473, JUN 86

Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

S/N 0102-LF-014-6603

UNCLASSIFIED

Approved for public release; distribution is unlimited.

Evaluation and Selection of a Telecommunications System
at the Naval Postgraduate School BOQ

by

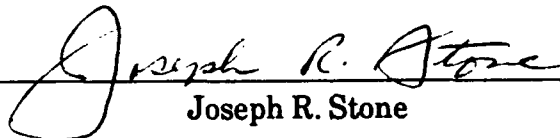
Joseph R. Stone
Lieutenant, United States Navy
B S., University of South Carolina, 1983

Submitted in partial fulfillment
of the requirements for the degree of


MASTER OF SCIENCE IN TELECOMMUNICATIONS SYSTEMS
MANAGEMENT
from the


NAVAL POSTGRADUATE SCHOOL
March 1991

Author:


Joseph R. Stone

Approved by:


Myung W. Suh, Thesis Advisor


William R. Gates, Second Reader

 Acting Chairman

David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

Acquiring telecommunication equipment and services requires a business approach in developing requirements and translating them into an RFP. The purpose of this thesis is to demonstrate the actual specification for a Digital Private Branch Exchange (DPBX) and Voice Response System and the review of Request For Proposals (RFP) in order to select the most cost effective proposal. The approach used towards evaluating vendor proposals consists of Life Cycle Analysis, Net Present Value, and Total System Effectiveness models.

Accession For	
NTIS CRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	BACKGROUND	1
B.	OBJECTIVES AND METHODOLOGY	2
C.	ORGANIZATION OF THESIS	3
II.	SPECIFICATIONS FOR A BOQ DPBX AND VOICE RESPONSE SYSTEM . 4	
A.	INTRODUCTION	4
B.	GENERAL REQUIREMENTS FOR DPBX	7
1.	Service Continuity and Compatibility	7
a.	Service Continuity	7
b.	System Compatibility	8
2.	Compatible Numbering Plan	8
3.	Unattended Console Feature Requirements	8
4.	Console Operation	9
a.	Full Access	9
b.	Control Restriction	9
c.	Split Calling	9
d.	Call Completions	9
e.	Busy Verification	9
f.	Call Transfer	10
g.	Attendant Resignaling	10
h.	Switched Loop Operation	10
i.	Access to the Attendant Console	10
j.	Trunk-to-Trunk Connection	10

k.	Queued Calls	11
l.	Three-way Calling	11
m.	Lamp Verification	11
n.	Protection and Alarms	11
5.	Station Equipment	11
a.	Telephone Instruments	11
b.	Station Wiring	12
c.	Telephone Company Facilities	12
6.	Standard Station Features	13
a.	Room Occupancy	13
b.	Station Restriction	13
c.	Automatic Wakeup Service	13
d.	Station-to-Station Dialing	14
e.	Station-to-Trunk Dialing	14
f.	Station-to-Tieline Dialing	14
g.	Dual Tone Multi-Frequency (DTMF) Operation-Dial Pulse	14
h.	Message Waiting	14
i.	Automated Call Billing	14
j.	Charges	15
k.	Summary Report	15
7.	Other Features	15
a.	Interface Equipment	15
b.	Authorization Code Calling	15
C.	GENERAL REQUIREMENTS FOR VOICE RESPONSE SYSTEM . . .	16
1.	Voice Mail & Auto Attendant	16

2.	Method of Operation	16
a.	Operation	16
b.	Optional Capabilities	19
3.	Message Creation and Operating Capabilities . .	19
a.	Question and Answer Mode	20
b.	Remote Message Retrieval	20
c.	Caller Interactive Mode	20
4.	Network Access Requirements	22
5.	Management Information	22
6.	Support Requirements	23
a.	Support Services	23
b.	Training	23
c.	Initial Voice Response Messages	23
7.	Electrical and Noise Protection	24
8.	Interconnect Provisions	24
9.	Maintenance	24
10.	Warranty	25
11.	Site Preparation	25
D.	CABLE DISTRIBUTION SYSTEM	25
1.	Asbestos Clause	25
2.	Outside Cable Distribution	26
3.	Demarcation	26
4.	Voice Interconnect Arrangements	26
E.	SYSTEM ORIENTATION AND TRAINING	27
1.	Initial Telecommunications Orientation	27
2.	Seminar Content	27

3.	Operator Training	27
4.	Automated Call Billing System Training	28
5.	Training Documentation and System Technical Manuals	28
6.	Maintenance Service Training	28
F.	WARRANTY/GUARANTEE	29
1.	Warranty Period and Guarantee	29
2.	Spare Parts	29
3.	Maintenance	30
4.	Test/Acceptance	30
G.	INSTALLATION PLAN	30
1.	Installation Plans and Engineering Data	30
a.	System Installation Milestone Plan	30
b.	Inside Plant Engineering Data and Installation Plan	31
2.	Telephone Management System Engineering Data and Installation Plan	31
3.	Outside Plant Engineering Data and Installation Plan	32
4.	House Distribution Cable, Inside Wire Engineering Data and Installation Plan	32
5.	Installation Test Plan Procedures	33
a.	System Installation Test Plan Procedures	33
b.	Test Documentation	33
H.	TRAINING PLAN AND DOCUMENTATION	34
1.	Training Plan	34

I.	SUPPORT ITEMS LIST (SIL)	34
1.	Inside Plant System Support Item List	35
2.	Outside Plant System Support Item List	35
3.	Systems Logistic Support Analysis Record Data	35
4.	Inside Plant Logistics Support Analysis Record	35
5.	Outside Plant Logistics Support Analysis Record	35
6.	System Spare Parts List	35
7.	Inside Plant Spare Parts List	36
8.	Outside Plant Spare Parts List	36
J.	SYSTEM/EQUIPMENT FAILURE ANALYSIS AND CORRECTIVE ACTION	
	REPORTS	36
1.	Project Status Report	36
2.	Progress/Status Meeting Report	36
3.	Contractor Quality Assurance Plan	36
K.	EMPLOYEES SECURITY REQUIREMENTS	37
L.	SAFETY	37
M.	CHAPTER CONCLUSION	37
III.	REQUEST FOR PROPOSAL REVIEW	39
A.	TECHNIQUES OF EVALUATION	40
1.	Eliminate Proposals That Fail to Meet Mandatory Requirements	40
2.	Create a Response Matrix	40
3.	Review Features in Detail	42
4.	Perform a Life Cycle Analysis	42
a.	Life Cycle Factors	43
5.	Pay-Back Period/NPV	48

a. Pay-Back-Period	48
b. Net Present Value	49
6. Review Technical Performance of the Top Proposals	53
IV. FEDERAL TELECOMMUNICATIONS SYSTEM 2000	55
A. INTRODUCTION	55
B. FTS-2000 SERVICES	56
1. Switched Voice Service (SVS)	56
2. Switched Data Services (SDS)	57
3. Packet Switched Service (PSS)	57
4. Dedicated Transmission Service (DTS)	58
5. Video Transmission Service (VTS)	58
6. Switched Digital Integrated Service (SDIS)	58
C. FTS 2000 LINKAGE WITH SX-200D DPBX	59
V. SUMMARY AND RECOMMENDATIONS	60
A. SUMMARY	60
B. RECOMMENDATIONS	61
APPENDIX A	63
APPENDIX B	64
APPENDIX C	67
LIST OF REFERENCES	71
INITIAL DISTRIBUTION LIST	72

I. INTRODUCTION

A. BACKGROUND

The Naval Postgraduate School Bachelor Officer Quarters (BOQ) has a requirement to install a new telecommunication system that would provide rooms in the BOQ with telephone service. Currently no phone system is in place and as a consequence operations at the BOQ are far short of their primary goal of providing top quality service. The BOQ provides rooms for both permanent party personnel and transient personnel attending courses at NPS. Frequent complaints are made by guests concerning the lack of in-room phone service that forces them to locate and use pay phones within the BOQ. In addition, the BOQ staff personnel receive important messages for guests that have to be delivered on short notice. This puts a strain on the staff. They often must deliver messages while checking guests in or out, answering questions regarding BOQ policy, or taking reservations on the phone. By having a phone system, the day-to-day stress will be greatly reduced and the staff will be able to provide more personalized service to their guests in a less hurried fashion. To remedy the situation, the BOQ officer has located a MITEL SX-200D Digital Private Branch Exchange (DPBX) that was stored as excess equipment at another Naval Base. The

DPBX and peripheral equipment were shipped to NPS and have been awaiting a final contract proposal and bid from vendors to complete the installation.

B. OBJECTIVES AND METHODOLOGY

The objective of this thesis is to help complete this project by updating the existing requirement specifications, finalizing the Request For Proposal (RFP), and developing a plan for reviewing the contract proposals for this new telecommunication system. A voice mail system requirement has been developed to provide even better services to guests and increase the effectiveness and morale of BOQ staff personnel.

Since the enactment of the Brooks Act (PUBLIC LAW 100-440-SEPT. 22, 1988) has made the Federal Telecommunications Systems (FTS) 2000 mandatory, an analysis of the FTS 2000 network will be performed to determine the feasibility of its linkage with the DPBX for enhanced service offerings.

The information obtained for this thesis was gained by reviewing technical documents from vendors, conducting interviews with Public Works telephone personnel, and reviewing existing specifications for a generic DPBX system. Extensive conversations with vendor representatives helped to ascertain the various capabilities of the DPBX and Voice Response systems. In addition, a two day conference concerning FTS 2000 provided an opportunity to interview telephone

specialists from various military commands and private industry.

C. ORGANIZATION OF THESIS

This thesis will start by describing in Chapter II the specifications and requirements for a Digital Private Branch Exchange (DPBX) and Voice Response System that will be installed and operated at the Naval Postgraduate School Bachelor Officers Quarters (BOQ). Chapter III will then discuss procedures for reviewing proposals from vendors and selecting the most cost effective proposal. Chapter IV will discuss the FTS 2000 network and its linkage with the BOQ DPBX system. Chapter V will draw some conclusions about the overall process of determining user requirements for telecommunication systems, developing the RFP that will be used to evaluate bids from vendors, and the process of evaluating the proposals and selecting the most cost effective proposal. Finally the FTS 2000 and its impact on the BOQ will be discussed.

II. SPECIFICATIONS FOR A BOQ DPBX AND VOICE RESPONSE SYSTEM

A. INTRODUCTION

A Request For Proposal (RFP) for a Digital Private Branch Exchange and Voice Response System for the BOQ was developed from an existing RFP that had been written by Public Works Personnel from the Naval Postgraduate School, BOQ staff and personnel from the Naval Computer Telephone Station. This chapter describes the original RFP and modifies it to reflect the SX-200D DPBX system acquisition. An additional requirement was identified for a Voice Response System and has been included in this chapter. This specification is submitted to potential contractors requesting to bid on the proposal.

The RFP serves as a management tool to provide vendors with the details of the requirement for the desired telecommunication system; i.e., it is a document designed to provide guidance to vendors. The RFP also serves as a framework for system evaluation and selection, which consummates the following three-step process of identifying users requirements and awarding the contract:

1. Identify the need.
2. Define the requirement specification.
3. Evaluate the proposal.

The need for a telecommunications system at the NPS BOQ was established in Chapter I. The specifications of the system

that can satisfy this need are defined in the subsequent sections. Finally the evaluation of proposals will be discussed in Chapter III.

As a management tool, the RFP establishes the requirements and defines the responsibilities of the contractor in installing, wiring, furnishing additional equipment as necessary, and integrating the government-owned SX-200D Hotel DPBX telephone system with existing government-owned cabling and equipment for the BOQ at the Naval Postgraduate School NPS. The SX-200D DPBX system is now wired to the back board telephone panel located in the main telephone room in building #220 (see Figure 1). The configuration of the SX-200D DPBX is summarized in Appendix A.

The telephone system and related equipment for the NPS BOQ, to be installed in buildings 220, 221, and 222, will consist of 150 lines and 24 trunks with the expansion capability to 500 lines and 48 trunks. (Table 1). Each station shall be provided with commercial hotel/motel type service features. The BOQ telephone system will provide real-time billing data for every local, local toll, and long distance toll (including overseas), and WATS calls made within the system. AUTOVON shall be provided to all stations with no charge to the users. The billing data shall be available in plain language to the attendant at the BOQ front desk, located in Building #220.

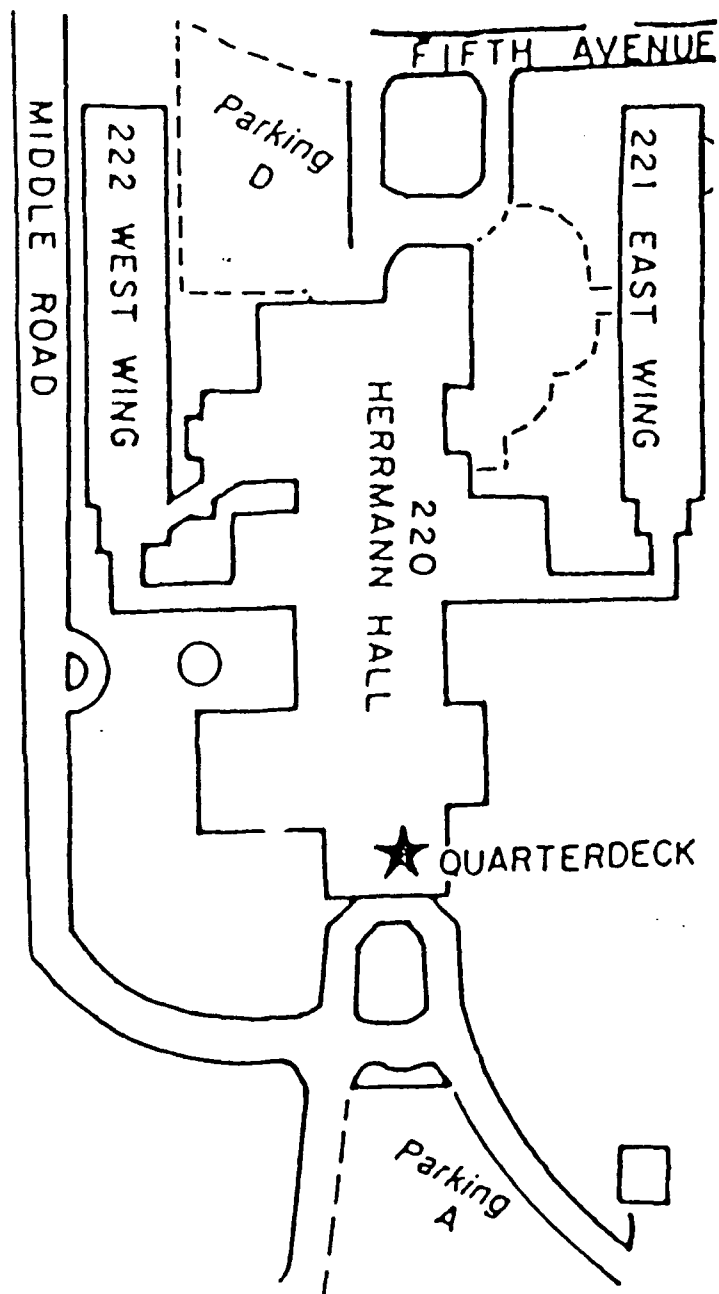


Figure 1. BOQ Layout

TABLE 1. PROJECTED USAGE AND PROJECTED CAPACITY AT NPS BOQ

	<u>EQUIPPED</u>	<u>WIRED</u>	<u>CAPACITY</u>
TRUNKS:	24	24	48
STATIONS:	150	150	500

B. GENERAL REQUIREMENTS FOR DPBX

The following requirements are modifications from the original specifications written for a generic PBX system. When the SX-200 DPBX system was acquired, the Naval Computer Telephone Station (NCTS) assisted NPS BOQ personnel with the changes to reflect the system unique features. The general requirements that follow are similar to those written by the NCTS but have been modified to reflect changes in current requirements and the addition of a new Voice Response System requirement. The SX-200D DPBX and peripheral equipment shall be wired and integrated to meet all the requirements as set forth in this specification.

1. Service Continuity and Compatibility

a. Service Continuity

The facilities provided to accommodate initial requirements shall be such that any growth as reflected in

this specification can be implemented without any service interruption or major modification of facilities.

b. System Compatibility

The contractor shall be solely responsible for compatibility of the system/equipment with all circuits and facilities provided by the Local Exchange Carrier (LEC) or other providers of service needed to meet the installation requirements of this specification.

2. Compatible Numbering Plan

The contractor shall be responsible for compatibility of the proposed system numbering scheme with the numbering plans for commercial and Government networks.

The numbering scheme for the proposed system shall include one, two, and/or three digit trunk access codes for user access to trunks/services. The following trunk access codes are mandatory:

- (0) Operator (information and other requests for assistance)
- (9-1) Toll/Long Distance Commercial Routing
- (9) Local Commercial Routing
- (8) AUTOVON Access
- (7) Tieline

3. Unattended Console Feature Requirements

At system initialization, the government-owned SX-200 LCD Console shall be installed and integrated to operate to the fullest extent possible. The console shall be equipped with dual operator handset and handset jacks. The attendant console will be located in Building 220, Room 118, in the BOQ front desk area.

4. Console Operation

a. Full Access

The console shall have full access to all trunks and stations terminating on the Hotel/Motel DPBX System.

b. Control Restriction

The attendant shall be able to change class-of-service on lines and trunks from the system access terminal, collocated at the attendant console, and to assign and cancel authorization codes as required.

c. Split Calling

The attendant shall be able to converse privately with either the calling or called party on trunk calls through the controls on the console.

d. Call Completions

The attendant shall be capable of completing trunk-to-trunk, station-to-trunk, trunk-to-station, and station-to-station calls for all circuits.

e. Busy Verification

The attendant shall be able to determine if a busy station line is actually in service. This feature shall place a warning tone on the line being verified before completing the talking path. The attendant shall be able to release a connection after busy verification is completed.

f. Call Transfer

The attendant shall be able to transfer trunk calls to and from any station line upon request.

g. Attendant Resignaling

All transferred and camped-on calls that have not been completed shall automatically be returned to the attendant. A visual and audible signal on the console shall be given to the attendant.

h. Switched Loop Operation

Each call requiring attendant assistance shall automatically be switched to a loop on the attendant's console. The call shall automatically release from the console when answered by the called station. The call may be held at the console if desired by the attendant.

i. Access to the Attendant Console

Access shall be provided to the attendant's console for assistance from any station within the Hotel-Motel system by calling an access code. The attendant's console shall also be accessible by dialing the separately listed directory number.

j. Trunk-to-Trunk Connection

The attendant shall be able to extend Incoming and outgoing trunk calls.

k. Queued Calls

Incoming calls to the attendant shall be automatically placed on hold when the attendant is busy. The calls shall be distributed on a first-come, first-serve basis.

l. Three-way Conference

The attendant shall be able to set up multiple conference calls, to include lines as well as trunks.

m. Lamp Verification

The system shall be provided with a lamp test to verify that all console lamps are serviceable.

n. Protection and Alarms

The system shall be completely wired and equipped with trouble signals and fuses. Print-out on the system fault recorder and visual alarms indicating fuse operation and other circuit malfunctions resulting from component failure shall be provided.

5. Station Equipment

In addition to the inventoried SX-200 equipment listed in Appendix A, the following station equipment is necessary.

a. Telephone Instruments

Single line telephone instruments with dual tone multi-frequency key pads and a message waiting indicator feature shall be provided by the contractor. The instruments shall be equal to or better than the quality, design, construction and performance of the telephones used by the

local telephone company, and approved for use by the Contracting Officer. Each telephone will be equipped with a plastic overlay which displays the feature codes available to the user.

One hundred fifty (150) single line instruments are required, including 13 speaker phones for the ten (10) designated VIP Quarters (3 suites will have telephones in each room).

b. Station Wiring

Telephone jacks and station wiring exists and is assumed to be operable in all rooms (stations) unless deemed otherwise by the contractor. Station wiring (house cable) shall be provided by the Contractor were needed. The following buildings will require station wiring:

<u>Building No.</u>	<u>Condition</u>
220	Interior wiring is required
221	Interior wiring is required
222	Interior wiring is required
	(BOQ Spaces Only)

The contractor is responsible for providing complete service to including all necessary house cable station wire, station connections, and station equipment.

c. Telephone Company Facilities

Interconnect facilities will be provided by the LEC.

6. Standard Station Features

a. Room Occupancy

The contractor shall provide the ability to visually display the occupancy status of each room. The status of the room shall be changeable by the telephone instrument in the room and by a keyboard terminal located at the attendant's position.

b. Station Restriction

The attendant shall be able to control the station restrictions placed on any room telephone by using a Customer Administrative Panel located at the attendant's position. The types of station restrictions required are: outward dialed calls, inward dialed calls, total restriction, and toll call restriction.

c. Automatic Wakeup Service

The contractor's equipment shall provide an automatic wakeup service. This wakeup service shall permit the attendant to instruct the switch to automatically call a station at a specified time. The attendant shall be able to cancel and activate a wakeup call from the attendant's position. The equipment shall provide a printed record of the wakeup request, station (room) number requesting the wakeup, wakeup time, wakeup cancellation, and indication if the wakeup call was answered.

d. Station-to-Station Dialing

Each station user shall be able to directly dial any other station (unless restricted) within the Hotel/Motel System without the assistance of the attendant.

e. Station-to-Trunk Dialing

Stations shall be able to dial, without attendant assistance, any trunk which their class of service mark permits.

f. Station-to-Tieline Dialing

Stations shall be able to dial, without attendant assistance, any local tieline which their class of service mark permits.

g. Dual Tone Multi-Frequency (DTMF) Operation-Dial Pulse

Stations marked for DTMF operation shall be usable with a touch tone telephone.

h. Message Waiting

The Contractor shall provide the attendant's position with the ability to activate and de-activate a message waiting lamp at each of the station instruments.

i. Automated Call Billing

Traffic management data shall be provided on a hard copy printout for each station (room) and authorization code. Arrangements shall be provided for automatic data printouts on command for variable intervals as required and shall be equipped with automatic start and stop. Measurement

equipment shall store data up to 24 hours which shall include all dates and times.

j. Charges

The charge for non-toll calls will not be affected by the length of the call. Charges for long distance and mid-distance calls will be determined by the government. The printout for each station will have a percentage figured into each call, the percentage will not be listed as a separate cost.

k. Summary Report

A summary report for a station must be made available upon request. The summary report must show extension, date, time, duration, location from which the call was placed and cost.

7. Other Features

a. Interface Equipment

The system shall have the capability of interfacing with "call billing" capabilities via the Billeting Automated Management System (BAMS).

b. Authorization Code Calling

Authorization codes shall be provided to allow individual billing when there is more than one occupant assigned to a station line. Call completion shall be automatically allowed or denied, based upon the class of service mark and other authorization code dialed for those calls to trunk groups requiring authorization codes.

C. GENERAL REQUIREMENTS FOR VOICE RESPONSE SYSTEM

The following requirements have been specified by the Navy Public Works Center for a Voice Response System. Some have been modified to reflect the BOQ's specific requirements.

1. Voice Mail & Auto Attendant:

The contractor is to provide voice mail with auto attendant features for 200 users and shall have expansion capacity to 500 users. The voice mail system will include all equipments necessary to provide all features and functions as specified. To comply with the features and functions specified, the contractor shall:

- * Provide all equipments identified and insure that the voice mail/auto attendant system and all peripheral equipments are compatible and fully integrated with the SX-200D DPBX System. This component of the automated system shall be new, of the latest design, and in current production.

- * Provide the total voice mail system, including (but not limited to) hardware, software, installation, maintenance, and follow-on service.

- * Provide script development assistance and system program support.

- * Provide a turn-key job.

2. Method of Operation

a. Operation

The voice mail system shall be stand-alone or built-in equipment that is modular in design and provides the

vendors customers with the state-of-the-art electronics voice telephone response service. It shall be capable of the following:

(1) Responding to and processing dual-tone multi-frequency (DTMF) signalling generated by telephone instruments.

(2) Responding to calls from users with other than DTMF telephone instruments. Every service that can be accessed by a caller with DTMF instruments shall also be accessible to callers with rotary instruments. Users with rotary telephones shall be provided with information from the voice response system by means of voice recognition or voice detection (i.e., the absence or presence of speech/sound).

(3) Providing for the storage of multiple message files with each file capable of storing multiple sub-messages. The system(s) shall have the capability to label and address each message file separately. (The term "Multiple Message Files" refers to the system having the capability to store and provide information related to the major topics in sub-files).

(4) Providing for an eight (8) port system and capable of expansion to accommodate a sixteen (16) port system. The system is to come equipped with 10 hours of message storage capacity.

(5) Answering of multiple calls while simultaneously providing other ongoing processing functions, such as routing

calls, leaving voice mail messages, discriminating information, providing status information etc.

(6) Instructing callers on access operations: i.e., how to retrieve or leave system messages.

(7) Allowing the caller to bypass the message directory in order to quickly access the desired message. The system shall provide callers with rotary instruments as outlined above. Callers with DTMF instruments should be able to access up to ten additional messages, after completion of the initial message. The system should provide these additional messages without the caller having to recall the system. Subsequent message access should be provided within an average of five seconds of request.

(8) Allowing callers who wish to speak with live operators to be automatically transferred via DPBX or Centrex using standard hook flash signalling without directly going through an operator, if one is available, or to a voice mailbox.

(9) Allowing system managers to remotely call into the system in order to change information messages on demand, without interrupting the operation of the system to callers accessing messages.

(10) Allowing BOQ staff personnel to enter a pass code in order to make system changes from a remote location.

(11) Changing the flow of information messages automatically at designated time intervals based on the time of day or day of week.

(12) Providing independent line operation whereby different applications can run off the same system simultaneously.

(13) Allowing for future upgrades to dial out to pre-determined lists of telephone numbers, deliver voice messages, and record both touch tone and/or voice responses.

(14) Providing a single Central Processing Unit, monitor, programming software, and operating system software as a part of a complete package. An internal modem must be included for remote diagnostic and programming assistance.

b. Optional Capabilities

The system should be capable of sending emergency messages to blocks of rooms simultaneously and with a minimum time required for attendant intervention e.g., fire in the West Wing of Building 222). To request evacuation of all personnel in Bldg. 222, the auto-attendant could be programmed to inform all guests on the 2nd floor of bldg. 222 to please evacuate.

3. Message Creation and Operating Capabilities

The system shall allow the creation of multiple major messages and sub-messages files. Messages created in these files shall be any length, to the maximum capacity of the system storage device.

a. Question and Answer Mode

The voice processing system shall provide for a question and answer mode, which shall provide the capability for all callers (i.e., DTMF and rotary) to directly connect to a specific message application, listen to the message and, if required, provide a response to a specific series of questions. This capability shall work in concert with the regular answer mode (i.e., while other callers are listening to and accessing other recorded messages).

b. Remote Message Retrieval

The system shall provide for remote retrieval of messages left during the question and answer mode (password or access code protection required). The remote retrieval capability shall be performed by inputting DTMF signals from a standard telephone. The system shall automatically delete individual caller stored messages once the transcriber completes the transcription of one message and begins transcribing the next.

c. Caller Interactive Mode

The system shall provide for a question and answer interactive mode which permits callers to leave one or more responses (i.e., recorded messages) in the following manner:

(1) Upon accessing the system, callers shall immediately hear a pre-recorded message which introduces a series of questions.

(2) Each pre-recorded question shall be followed by a beep or tone indicating the start of the recording of the callers response.

(3) The last pre-recorded question in the series of questions will offer the caller the option of being automatically connected to a live attendant, another telephone, or the local Data Base. It will instruct the caller to disconnect (i.e., hang up) if they decline the offer. The system shall be capable of recognizing the callers that are still connected after a pre-determined threshold and automatically connect the caller to a live attendant at a predetermined 4, 5, 7 or 8 digit telephone number (i.e., caller transfer).

(4) The call transfer feature of the question and answer mode shall be capable of being deactivated and/or deactivation shall be password or access code protected.

(5) For ease of subsequent retrieval, the system shall store only the caller's response and not the pre-recorded questions.

(6) Capacity shall be provided by the system to store the caller's response to each question. The total storage capacity of the system (when programmed to function solely in the question and answer mode) shall be 10 hours with future capability to expand up to 40 hours of message storage.

4. Network Access Requirements

The voice processing system shall be compatible with all circuits connecting to the facilities of the local exchange and inter-exchange telephone companies: 800 service, Automatic Voice Network (A/V) Telecommunications Service lines, consolidated Area Telephone System (CATS) lines, and Federal Telecommunications Service lines (FTS). The voice processing system shall connect to these facilities through standard USOC telephone interface jacks.

5. Management Information

Management information shall be provided by the voice processing system as specified in this section. Displayed and printed MI shall be automatically provided on demand. Demand reports shall be available for individual fields or as a combined report for all informational fields. System design will be such that reports can be customized by BOQ staff personnel and designated programmers. A demand report screen displayed and/or printed shall not destroy cumulative data. The system shall store MI (cumulative data for a period of one week) until BOQ staff personnel zero out cumulative totals. The MI shall be formatted in a simple, easy to follow pattern and free of jargon or data not related to the system. The MI system shall provide the following:

- * Total number of calls received over each line. Offeror to provide a sample report.

* The number of callers that disconnected before accessing a message or receiving the initial message in its entirety per message file.

* Amount of available storage space at any given time.

6. Support Requirements

a. Support Services

Support services are contractor-provided services which will ensure the system is operating properly, including all associated hardware and software. The contractor is expected to provide sufficient support to not only assure proper system operation but also ensure that the users can adequately manage the system. Offeror shall include a copy of their warranty, maintenance programs, and contracts.

b. Training

The contractor shall provide training for BOQ selected personnel. Training shall include sufficient time to cover all aspects of the voice mail and auto attendant system operation. The contractor shall provide the training at the BOQ work site and at a time that is mutually agreeable to all parties receiving training.

c. Initial Voice Response Messages

The contractor shall ensure that all initial voice response system messages are completed and operating. The contractor shall ensure that all system operation parameters are based on the BOQ requirements.

7. Electrical and Noise Protection

The system shall be equipped with an electrical power protection device that will prevent harmful surges or decreased incoming commercial power from damaging the voice processing system. It shall meet all applicable electrical and building codes at the site. The equipment shall be relatively noise-free and not disruptive to normal office environment.

8. Interconnect Provisions

The contractor shall guarantee that the system and all its components are certified and registered by the Federal Communication Commission (FCC) for direct connection to the public network. The contractor shall also provide a statement specifying the FCC registration number and ringer equivalent in decibels. (Offerors are to indicate FCC registration number and ringer equivalents in decibels).

9. Maintenance

Maintenance shall be provided by the contractor as follows:

- * The contractor shall provide maintenance of the installed system on both a preventive (scheduled) and remedial basis. This service shall be provided on-site.

- * The contractor shall have an existing service office within a forty-mile radius to the Naval Postgraduate School, Monterey, California. The Contractor shall effect repair within 2 working hours of notification on remedial services.

Total system failure shall be corrected within 4 working hours of notification.

* The contractor shall provide as an option a maintenance contract outside the initial twelve month warranty.

10. Warranty

The contractor shall furnish all labor, parts, and materials necessary to keep any equipment acquired under this contract in good operating order for a period of 12 consecutive months from the cut-over date. Warranty coverage shall include maintenance service as described above.

11. Site Preparation

NPS BOQ agrees to have the site prepared in accordance with the contractor's written equipment environmental specifications, as agreed to in writing by NPS and the contractor. The contractor shall install the voice processing system in a manner that complies with all applicable building and electrical codes. (Offeror to indicate specific site preparation requirements).

D. CABLE DISTRIBUTION SYSTEM

1. Asbestos Clause

Asbestos exists in shafts, tunnels and basement areas. If asbestos is encountered, the contractor and his employees must avoid coming in contact with the material.

Public Works Dept. must be immediately notified before proceeding with any work in an asbestos environment.

2. Outside Cable Distribution

The outside cable distribution system to be installed shall be the property of the Naval Postgraduate School, Monterey, California. The proposed telephone system is not to be interconnected with the current base telephone system at NPS, except for six trunk lines to allow access to NPS four digit number system and the appropriate number of AUTOVON lines.

3. Demarcation

The contractor, in coordination with the LEC and Government, shall establish a single demarcation point of connection within the building (Building 220) between the contractor-provided equipment and that which is provided by the LEC(s). The point of interconnect for circuits and telephone lines shall be in the existing telephone system equipment room on existing relay racks.

4. Voice Interconnect Arrangements

Interconnect arrangements and other local telephone company-provided support equipment located on site with the system are required to have continuous power equivalent to that provided for the switching equipment. The contractor shall coordinate these support equipment and power requirements with the local telephone company and be

responsible for those facilities necessary to provide continuous power.

E. SYSTEM ORIENTATION AND TRAINING

The contractor shall provide the Government with on-site system orientation and training as follows:

1. Initial Telecommunications Orientation

The contractor shall conduct an eight hour (one day) session covering orientation for Government management officials twenty (20) days prior to system initialization. The orientation, at a minimum, shall include an explanation of basic principles, theory, and structure of the system as well as demonstrations of equipment operations and features.

2. Seminar Content

At a minimum, the user training program shall provide users with a one-hour orientation on the basic operation of the system. The training will consist of demonstrations and practical exercises in the use of system features. The program of instruction and sample seminar shall be provided for the approval of the Contracting Officer of Naval Postgraduate School and key management officials twenty (20) working days prior to start of training.

3. Operator Training

Operator training will be provided for two (2) Government designated representatives. The contractor shall conduct on-site training sessions twenty (20) days prior to

cutover date to train personnel in the operation of the attendant position. Instruction shall cover operational functions and procedures and provide familiarity with visual and audible signals and alarms. Instruction shall be conference (25 percent) and demonstration/practical exercise (75 percent). To insure continuity of operation, all practical exercises will be coordinated with the Contracting Officer or his authorized representative. In the event of conflict between operations and training, operations will have priority. Training hours may be other than normal duty hours in the event that the operational schedule precludes utilization of equipment for practical exercises. The operator training shall not exceed five (5) hours per operator.

4. Automated Call Billing System Training

Call Billing System training will be provided for two (2) Government designated representatives.

5. Training Documentation and System Technical Manuals

Training documentation and system technical manuals shall be specified in the applicable Contract Data Requirements List.

6. Maintenance Service Training

Preventive and corrective system maintenance training shall be provided to a designated Government representative.

F. WARRANTY/GUARANTEE

1. Warranty Period and Guarantee

The contractor shall provide warranty documents indicating that all equipment shall conform to its published specifications and be free from defects in material and workmanship. The contractor shall guarantee all wiring and equipment to be free from inherent defects for a period of one (1) year from date of "in-service" acceptance. Replacement of parts or correction of any such defects, including labor, shall be rendered without additional cost to the Government within the guarantee period. Critical repairs shall be responded to within six (6) hours, normal repairs within 24 hours. The government also requires that the Contractor provide warranty on the government furnished equipment, for a period of one year from date of acceptance.

2. Spare Parts

The contractor shall provide Original Equipment Manufacturer (OEM) spare parts, suppliers, part number, and a full written description of items listed. The list shall also include test equipment and specialized tools and accessories required to maintain the Hotel/Motel System. The contractor shall guarantee the availability of replacement parts for a period of not less than five (5) years from the acceptance date. The spare parts list shall be submitted to the Contracting Officer and the Contracting Officer Technical Representative (COTR) showing part numbers, unit costs, and

other pertinent information for easy identification, which may be procured at a later date.

3. Maintenance

The contractor shall provide a government option price for contractual maintenance services as needed beyond the warranty period.

4. Test/Acceptance

Test/acceptance of the services and equipment provided by the contractor will be the responsibility of the Contracting Officers Technical Representative (COTR) and will be based on the degree to which total services and equipment comply with those standards set forth in the specification. Test/Acceptance will be conducted on site at a date mutually agreed upon by the Contractor and COTR.

G. INSTALLATION PLANS

1. Installation Plans and Engineering Data

a. System Installation Milestone Plan.

The plan shall identify major subsystems installations (Inside Plant, Telephone Management System, Outside Plant, House distribution Cable, and Inside Wire) to provide a complete and operational system cut-over.

b. Inside Plant Engineering Data and Installation Plan.

The plan shall identify the necessary actions and supporting data to accomplish installation of the inside system plant as follows:

(1) Switch configuration identifying circuit packs for trunks and lines and trunk group configurations.

(2) Battery backup power requirements identifying quantities of batteries, rectifiers, etc.

(3) Air conditioning requirements identifying power consumption and heat dissipation of all inside system plant equipment, cooling, air handler and air distribution requirements for the heating loads operated.

(4) Plans shall identify the delivery, start and completion date, testing period and cutover of the outside plant building alterations, switching systems and attendant consoles, systems initialization, battery and power equipment, fire protection equipment, air conditioning system equipment and other equipment as proposed by contractor.

2. Telephone Management System Engineering Data and Installation Plan

The plan shall identify the necessary actions and supporting data to accomplish installation of the Telephone Management System (TMS) as follows:

- * The TMS configuration, identifying storage devices, random access and read only memory sizes (identified by system subsystems).

- * The air conditioning requirements identify power consumption and heat dissipation of all TMS equipment, as well as cooling, air handler, and air distribution requirements of the heating loads generated.

3. Outside Plant Engineering Data and Installation Plan

The plan shall identify the necessary actions to accomplish installation of the outside plant system. Engineering data shall identify the following:

- * Support structures.
- * Transmission medium

Should the contractor purchase and /or use any existing transmission media as part of the proposed system, the plan shall include a proposal from the incumbent contractor to continue using the existing media for government service requirements until the new system is installed and operational.

4. House Distribution Cable, Inside Wire Engineering Data and Installation Plan

Engineering data shall identify the following:

- * Riser cable and building terminals
- * Interior wiring runs

Should the contractor purchase and/or use any of the existing house distribution and inside wire facilities

(including risers) as part of the installation of the system, the plan shall include a proposal for the incumbent contractor to continue using the existing media for government service requirement until the system is installed, operational and accepted.

5. Installation Test Plan Procedures

a. System Installation Test Plan Procedures.

The plans shall identify test procedures to ensure equipment for the SX-200 switch is physically and functionally checked out, and documentation will be provided to demonstrate the adequacy of the installation.

b. Test Documentation

Appropriate Test Documentation shall be prepared and maintained throughout the installation testing period. The records obtained during the operational test include: failure and unsatisfactory reports; listings of parts and components replaced during each phase of installation testing; an operational test log with a chronological listing of significant events; all equipment/facility reactions; meter readings; etc. Copies of all recorded or photographed test data shall also be provided.

Documentation shall be provided for the following:

(1) Inside Plant Test Documentation including switching equipment, attendant consoles, power plant system equipment, air conditioning system and fire protection system.

(2) Telephone Management System Test Documentation, including any additional hardware and software, CDR/SMDR, and air conditioning system.

(3) Outside Plant System Test Documentation from the MDF to each building terminal/floor terminal.

H. TRAINING PLAN AND DOCUMENTATION

1. Training Plan

The plan shall address the training objectives and materials that will be provided for General User Training, Attendant Console Training, Switching System Training, Telephone Management System Training and Billeting Automated Management System.

2. Training Documentation

Training documentation shall be provided as follows:

- * Initial Telecommunications Orientation Documentation
- * Switching System/Telephone Management System Training Documentation
- * Operator Training Documentation
- * General User Training Documentation
- * Technical Training Documentation

I. SUPPORT ITEMS LIST (SIL)

These lists will include tools and test equipment necessary to perform on-site level of maintenance as follows:

1. Inside Plant System Support Item List

This list identifies and functionally describes the various types of tools and test equipment necessary to perform diagnostic testing and maintenance of the inside plant equipment.

2. Outside Plant System Support Item List

This list identifies and functionally describes the various types, of tools and test equipment necessary to perform diagnostic testing and maintenance of the outside plant equipment.

3. Systems Logistic Support Analysis Record Data

These reports are required to identify parts replacements of the system installed.

4. Inside Plant Logistics Support Analysis Record

This data identifies the lowest replaceable unit and its relationship to the next higher assembly part of the inside plant equipment.

5. Outside Plant Logistics Support Analysis Record

This data identifies the lowest replaceable unit and its relationship to the next higher assembly part of the outside plant equipment.

6. System Spare Parts List

This list identifies the replacement parts of the system installed.

7. Inside Plant Spare Parts List

This list identifies the recommended spare parts, down to the lowest replaceable unit, necessary to perform on site maintenance of the inside plant equipment.

8. Outside Plant Spare Parts List

This list identifies the recommended spare parts, down to the lowest replaceable unit, necessary to perform on site maintenance of the outside plant equipment.

J. SYSTEM/EQUIPMENT FAILURE ANALYSIS AND CORRECTIVE ACTION REPORTS

This reports the failures and corrective actions which occur during installation and test phases of the system/equipment.

1. Project Status Report

This report is to apprise the CO/COTR/ACTOR of areas of difficulties and to indicate the status of the contractual effort as of the date of the report

2. Progress/Status Meeting Report

The progress/status meeting report records the minutes of periodic meetings between Contractor and CO/COTR to review jointly the project progress to date, reach decisions on major problem areas and determine the future course of the project.

3. Contractor Quality Assurance Plan

The contractor shall submit a quality assurance plan for the following items:

- * Inside Plant
- * Outside Plant
- * Inside Wire
- * Equipment
- * Training

K. EMPLOYEES SECURITY REQUIREMENTS

The contractor shall submit the following items:

- * List of Employees
- * List of Employees' Citizenship
- * List of Employees' Job Description

L. SAFETY

The contractor shall meet with the Base Commander, or his local safety representative, within fifteen (15) days of contract award for review of the safety requirements governing the specifications to be accomplished.

M. CHAPTER CONCLUSION

Following award of contract and before installation commences the Contractor shall conduct a meeting with key NPS and BOQ staff personnel to discuss all features offered, capabilities of the system and propose which features provide the best performance to facilitate telecom operations at the BOQ.

The SX-200D DPBX was successfully assembled and tested on Feb. 25, 1991 by Lobal Communications, Inc. of Seaside, CA. This verified proper operation of options and features including government owned control key PL-150. Installation of all printed circuit cards and testing of all bays, slots, and circuits was completed. Enabling of self diagnostics to test all hardware was completed. All hardware per in-house inventory was tested and assured to be in functional working order. As of Feb. 25, 1991 the government-owned SX-200D is completely operational and ready to be installed with the capacity of 12 Central Office Trunks and 144 single line extensions.

III. REQUEST FOR PROPOSAL REVIEW

The review of Request For Proposals (RFP) requires a well defined evaluation plan, developed to support the requirements and technical specifications spelled out in the RFP. This chapter focuses on the process of procuring a telecommunications system that meets the NPS BOQ's requirements and gives the best value per unit cost.

The objective in reviewing RFP responses is to efficiently screen out responses that have little likelihood of meeting the specified requirements. The evaluation should proceed from the easiest to the most difficult factors to assess. Those factors more difficult to assess include the technical and operational performance of the equipment being proposed. This assessment often requires meeting with users of similar equipment from the vendor under consideration.

The review process should afford the evaluators the capability to sift progressively through responses until the best overall vendor is identified. The following steps are recommended to evaluators in order to accomplish this task. [Ref. 1: p. 102]

A. TECHNIQUES OF EVALUATION

1. Eliminate Proposals That Fail To Meet Mandatory Requirements.

The coarsest screen consists of checking for compliance with mandatory features as specified in the RFP and determining if all requested information has been supplied by the prospective contractor. Failure to provide such information, or non-compliance with the requested features, is indicative that the vendor does not understand the scope of your requirements or simply cannot meet the specifications desired. The proposal(s) that fail to meet minimal acceptance criteria should not be totally discarded. If it is necessary to obtain additional information from several proposals, this may be indicative of ambiguous requirements stated in the RFP. Eliminating proposals by this first screen serves to reduce the proposals that warrant a more in-depth analysis to a manageable number.

2. Create a Response Matrix

A matrix chart should be developed and tailored to the specific desirable features being requested in the RFP. This puts both the features being offered and prices into focus and serves to check how well each proposal conforms to the requirements. The requirements for the BOQ telecommunication system have been put into a matrix in Table 2. The evaluators can use this matrix to check each proposal and eliminate those which are clearly outliers, either in offered features or price. Appendix B illustrates how the total cost of the project and the costs of each requirement are

estimated. Appendix C provides a schedule Contracting Officers may require each vendor to complete for the purpose of collecting cost data. This data could then be used in the matrix chart below.

Table 2. Sample Matrix for Comparing DPBX Proposals

STATIONS -150	VENDOR A		VENDOR B	
	COST	COST/STN	COST	COST/STN
STATION EQUIPMENT				
WIRING				
AUXILIARY EQUIPMENT				
CALL ACCOUNTING				
TRAINING PROPOSAL				
MAINTENANCE CONTRACT				
VOICE MAIL SYSTEM				
EXPANSION				
Total Cost:				

3. Review Features in Detail

In this step, requirements are checked against the vendors' response sheets and compared against the documentation provided by the vendor. This step takes a more in-depth analysis in that technical documentation is examined to determine if the equipment can do what has been stated on the response sheets. Also it must be determined how effectively the features will be implemented and integrated with the overall system.

4. Perform a Life Cycle Analysis

A Life Cycle Analysis (LCA) determines which of several alternatives consumes the least amount of capital throughout the life of an investment. The analysis is accomplished by compiling a financial model of the discounted cash flows expected from acquiring each product alternative. The present worth of the cash flows is summarized to identify the product with the lowest life-cycle cost (LCC). The product with the lowest LCC will consume the least amount of cash, in present value terms, throughout its product's service life. [Ref 1.] This method of analysis does not by itself indicate the most effective system, in terms of reliability of performance and ease of operation, but does provide a strong financial evaluation which can introduce more objectivity in making the final decision among competing alternatives.

a. Life Cycle Factors

The most effective way of obtaining life cycle cost information is to request it in the RFP. As long as the information can be verified, the vendor is the best source of this information. Typical life cycle cost factors for the telecommunication system under consideration in this thesis are as follows:

1. INITIAL COSTS:

- a. Purchase price of equipment
- b. Installation and wiring
- c. Initial Training
- d. Instructions and documentation
- e. Software
- f. Nonrecurring charges for common carrier services (tie lines, C.O. trunks)

2. RECURRING COSTS:

- a. Maintenance and repairs
- b. Recurring Training
- c. Recurring software fees
- d. Operating supply fees
- e. Electric power consumption
- f. Floor space and air conditioning requirements
- g. Rearrangements (stations, trunks, terminals, etc.)
- h. Common carrier services (trunks, lines, etc.)
- i. Upgrades and expansions

It should be noted that the primary role of telecommunications equipment is to support business and not necessarily generate a revenue. Therefore, it is often a cost of doing business and the most cost effective system will be the one with the lowest LCC.[Ref. 1]. There exists a possible flaw in choosing the system based solely on having the lowest life cycle cost. Although one system will likely stand out as the least cost in terms of LCC, another method which measures the systems overall effectiveness might indicate otherwise.

This latter approach, based on Total System Effectiveness, measures a variety of performance criteria.

First a Life Cycle Cost model will be developed and evaluated for the telecommunication system under consideration followed by a Total System Effectiveness analysis.

The following hypothetical model of a DPBX and Voice Response System is provided to illustrate the Life Cycle Analysis (LCA).

Table 3. Costs and Feature Comparison between Two DPBX and Voice Response Systems Proposals Offered by Vendor A & B. (Equipment and Installation)

	Vendor A	Vendor B
Initial Costs:		
Purchase price (includes equipment costs, wiring, and peripheral equipment)	\$54,000	\$49,000
Installation (Labor)*	11,000	10,000
Spares	1,500	1,100
Software	4,000	5,500
Total Initial Cost	<u>\$70,500</u>	<u>\$65,600</u>
Recurring Costs:		
Training (Quarterly)	1,000	2,300
Maintenance	4,500	6,500
Software Upgrades	0	1,000
Rearrangements	1,500	2,500
Total Recurring Costs:	<u>\$7,000</u>	<u>\$12,300</u>

* Purchase price represents "additional" MITEL equipment, Voice Response System, wiring/cable, training and maintenance contract.

Table 3 shows the comparison of two proposals and associated cost factors. Vendor A has higher initial costs

but the recurring costs are lower. Based on the totals in Table 3, it is not trivial to determine if the savings in recurring costs in vendor A's proposal is worth the extra initial cost. A Life Cycle Analysis (LCA) aids in assessing the tradeoffs by testing a range of assumptions. [Ref. 1: p.108]

Some of the factors to be used in the LCA model are summarized in Table 4.

**Table 4. Common Cost Factors
for PBX & Telephone Equipment**

Labor Cost per hour	\$40
Floor Space \$/sqft	4
Cost of Money	8%
Maintenance Inflation	5%
Equipment Service Life	20 YRS
Salvage Value	0

* The above figures are not representative of actual costs but are Listed for illustrative purposes.

The costs for owning and operating the equipment include factors such as cost of money, power and floor space. Another factor to be considered is the life of the equipment (useful service life). Since this analysis involves the evaluation of a DPBX system and Digital Voice Response System, the service life is figured to be 20 years. This is not a unrealistic figure for a DPBX system that is modular in design and has expansion capability to meet the users needs.

With the information in the preceding tables, the LCA model shown in Tables 5 and 6 can be developed in a spreadsheet program to compare the two proposals under consideration. Table 5 and 6 provide the discounted life-cycle-cost of the two proposals. It should be noted that there could be a number of proposals under review and using a spreadsheet program facilitates this analysis.

Table 5. Life Cycle Comparisons Between Two Different Vendors

<u>Product Costs</u>	<u>Vendor A</u>	<u>Vendor B</u>
Purchase Price	(\$54,000)	(\$49,000)
Installation (Labor)	(\$11,000)	(\$10,000)
Spares	(\$1,500)	(\$1,100)
Software	(\$4,000)	(\$1,100)
Total Installed Cost:	(\$70,500)	(\$65,600)
 Recurring Cost		
Maintenance	(\$4,500)	(\$6,500)
Training	(\$1,000)	(\$2,300)
Software Upgrades	0	(\$1,000)
Rearrangements	(\$1,500)	(\$2,500)
Total Recurring Cost:	(\$7,000)	(\$12,300)
 NET PRESENT VALUE	(\$114,451)	(\$147,145)
 Common Costs:		
Labor Costs/Hr.	\$40	
Maintenance Inflation	5%	
Cost of Money	8%	
Service Life (YRS)	20 YRS	

Table 6. Life Cycle Analysis for Two Proposals

Year	Vendor A	Vendor B
0	(\$70,500.00)	(\$65,600.00)
1	(\$7,000.00)	(\$12,300.00)
2	(\$7,000.00)	(\$12,300.00)
3	(\$7,000.00)	(\$12,300.00)
4	(\$7,000.00)	(\$12,300.00)
5	(\$7,000.00)	(\$12,300.00)
6	(\$7,000.00)	(\$12,300.00)
7	(\$7,000.00)	(\$12,300.00)
8	(\$7,000.00)	(\$12,300.00)
9	(\$7,000.00)	(\$12,300.00)
10	(\$7,000.00)	(\$12,300.00)
11	(\$7,000.00)	(\$12,300.00)
12	(\$7,000.00)	(\$12,300.00)
13	(\$7,000.00)	(\$12,300.00)
14	(\$7,000.00)	(\$12,300.00)
15	(\$7,000.00)	(\$12,300.00)
16	(\$7,000.00)	(\$12,300.00)
17	(\$7,000.00)	(\$12,300.00)
18	(\$7,000.00)	(\$12,300.00)
19	(\$7,000.00)	(\$12,300.00)
20	(\$7,000.00)	(\$12,300.00)
NPV	(\$114,451.04)	(\$147,145.19)

The LCC for Vendor A is \$32,694 less than Vendor B's LCC. This should be taken into account when attempting to justify the initial higher costs for Vendor A.

5. Pay-back Period/ NPV

a. Pay-Back-Period

The length of time required for the net revenues of an investment to return the cost of the investment determines the pay-back time and can be calculated in the following manner:

$$\text{pay-back period} = \frac{\text{Amount of Investment}}{\text{Estimated Annual Net Revenues}} \\ (\text{YRS})$$

The estimated cash inflows resulting from guests paying for telephone usage is approximately \$10,000 yearly. This is based on reviewing telephone records for the BOQ pay phones. Over a course of 12 months the receipts were approximately \$50,000. Of this amount, the Navy Resale activity receives about 20%. This amount is expected to accrue to the BOQ as a result in-room phone service. [Ref. 4: p.27]

To calculate the pay-back period for Vendor A using the pay-back formula, the net revenues is first calculated in the following manner: Cash Inflows(Revenues)-Recurring Costs. For Vendor A, the amount of investment is equal to \$70,500 which includes the purchase price of equipment and installation charges. The net revenues are \$10,000 - \$7,000= \$3,000. The pay-back period for Vendor A is then calculated as follows:

$$\text{pay-back period} = \$70,500/\$3,000 = 23.5 \text{ Yrs}$$

Vendor B will have an infinite pay-back because net revenues are negative, (\$10,000-\$12,300)= - \$2,300).

Although pay-back period is easy to calculate, it can lead to the wrong decisions. For instance, looking at pay-back period alone ignores future income beyond the payback period. If a project matures in later years, the use of the pay-back period can lead to the selection of less desirable investments.

b. Net Present Value

The Net Present Value (NPV) provides a method of ranking proposals. NPV is equal to the net present value of future cash flows resulting from purchasing the telecommunication system minus the present value of the cost of the system. Based on receipts of \$10,000 yearly, using an 8% cost of capital over a 20 year equipment life cycle, Table 7 illustrates NPV for the two proposals.

Although NPV is negative, indicating the investment yields a return less than the cost of money (discount rate), the reader is cautioned to consider the purpose of the investment. When evaluating telecommunication equipment, its primary role is to support the work force. In the case of the BOQ, staff efficiency will increase as well as customer satisfaction. Therefore, its primary purpose is not to generate a revenue. Systems with a negative NPV may be justified if the increase in quality of service and staff efficiency is sufficient to offset the negative NPV. [Ref. 1: p. 107]

Table 7. Net Present Value of Two Proposals

Year	Net Cash Flows	PV of \$1 at 8%	PV of Net Cash Flows
1	\$10K	.926	\$9,260
2	10	.857	8,570
3	10	.794	7,940
4	10	.735	7,350
5	10	.681	6,810
6	10	.630	6,300
7	10	.583	5,830
8	10	.540	5,400
9	10	.500	5,000
10		.463	4,630
11	10	.429	4,290
12	10	.397	3,970
13	10	.368	3,680
14	10	.340	3,400
15	10	.315	3,150
16	10	.292	2,920
17	10	.270	2,700
18	10	.250	2,500
19	10	.232	2,320
20	10	.215	2,150
Present Value of Future Cash Flows.....			\$98,170
Present Value of Required Investment Under Vendor A Proposal:			(\$114,451.04)
Present Value of Required Investment Under Vendor B Proposal:			(\$147,145.19)

6. Evaluate Total System Effectiveness

The total system as proposed by each vendor, must be evaluated against stated user requirements, and the winning vendor selected according to specified criteria. A system performance evaluation determines whether all the systems have the effectiveness required. [Ref. 4: p.18] To determine which system is most effective, the user must decide which attributes are to be considered in making the evaluation. These attributes become figures of merit (FOM) and are the basis for evaluating Total System Effectiveness.

Each FOM is assigned a value that ranks the FOM's from highest priority to lowest. These values are the same for all systems. Then a utility figure is assigned to each FOM for each system. The utilities reflect the relative performance of the alternatives for each attribute, as compared to a baseline system. Table 8 illustrates utility values and the corresponding criteria for each value.

In order to develop the utility value criteria and assign priorities to the attributes, it is necessary to work closely with the users, design engineers, and previous customers having similar systems. The attributes of importance and their priorities have been determined as follows:

Table 8. UTILITY ASSIGNMENT CRITERIA [Ref. 4: p.19]

UTILITY	CRITERIA
1	POOR
2	BELOW AVERAGE
3	MARGINAL
4	ABOVE AVERAGE
5	OUTSTANDING

1. Customer Referral Feedback (RF): 6
2. Customer Service (CS): 7
3. Expansion Capability (EC): 3
4. Maintenance Plan (MP): 8
5. Overall System Integration (OI): 4
6. Reliability (RE): 10
7. Training Plan (TP): 5
8. User Interface/Ease of Use (UI): 9

The following equation shows the system's total effectiveness when applying both the FOM and utility values.

$$T_i = 100[10(LCC_i) + 6(RF_i) + 7(CS_i) + 3(EC_i) + 8(MP_i) + 4(OI_i) + 10(RE_i) + 5(TP_i) + 9(UI_i)]$$

Total Effectiveness is represented by T_i where i represents the effectiveness of each vendor. [Ref. 4: p. 20]

The T_i value is multiplied by 100 to make the cost effectiveness values more measurable.

Total effectiveness is calculated for each alternative according to this equation. The calculation is illustrated in Table 9. Vendor A has the highest total system effectiveness demonstrating that this proposal is more effective overall in meeting the users requirements.

Table 9. Qualitative Effectiveness of Vendors

Variable	Vendor A	Vendor B
Referral Feedback (RF)	6(3)	9(4)
Customer Service (CS)	7(3)	7(4)
Expansion Capacity (EC)	3(4)	3(5)
Maintenance Plan (MF)	8(4)	8(3)
System Integration (OI)	4(5)	4(4)
Reliability (RE)	10(4)	10(3)
Training Plan (TP)	5(5)	5(3)
User Interface/Ease of Use (UI)	9(3)	9(4)
Total Effectiveness: $T_i =$	(100) 195	(100) 200

By combining the total effectiveness (T_i) with the total life-cycle-costs (LCC_i), a cost effectiveness ratio can be determined. This shows total effectiveness per dollar. The

cost effectiveness ratio (C_i) can be determined as follows:

[Ref. 4: p. 22]

$$C_i = \frac{T_i}{LCC_i}$$

In the example illustrated here:

$$C_A = \frac{19500}{114451.04} = .170 \qquad C_B = \frac{20000}{147145.19} = .135.$$

Thus, Vendor A has the optimal system according to this criteria. [Ref 4: p. 22]

7. Review Technical Performance of the Top Proposals

This step can be the most demanding and time consuming. It should be avoided until the proposals have been narrowed down to the ones which have an excellent chance of being selected. This review should be made on a working system installed by the vendor. At this time, the overall operation of the system should be evaluated, comparing its features to those that are requested in the RFP. Maintenance records should be examined, checking for down time and time to repair. Customer satisfaction and support services should be evaluated.

The evaluation process should retain more than one vendor, since final negotiations are more competitive with more than one finalist. As a rule, vendors not responding fully to the Request For Proposal (RFP) should be disqualified. The rules for required responses that the buyer will use for evaluation are spelled out in the RFP and/or a

separate cover letter to the vendor's accompanying the RFP.
[Ref. 1: p. 113]

The approaches outlined in this chapter provide the framework for evaluating and choosing among competing alternatives. While one method indicates one proposal is the most effective, in terms of lower initial cost, a further evaluation reveals that lower cost does not translate to lower life-cycle cost or maximizing customer satisfaction per dollar spent. It is the goal of the methodologies presented here to serve as a guide in selecting the most cost effective system proposal. This will significantly reduce the guess work in performing evaluations of competing proposals.

IV. FEDERAL TELECOMMUNICATIONS SYSTEM 2000

A. INTRODUCTION

The Federal Telecommunications System (FTS) 2000 is the replacement for the analog FTS voice network installed during the Kennedy administration. It is divided up into two packages (Network A and Network B). The Government Services Administration (GSA) manages the FTS 2000 contract. Representative Jack Brooks (D-TX) developed the Brooks Act making FTS 2000 mandatory for all agencies subject to the continuing appropriations bill. [Ref. 6:p. 112]

Originally the FTS 2000 RFP called for one vendor to serve the entire network. A lot of interest was generated in the telecommunications industry and a decision was made to split the network amongst two vendors. AT&T and U.S. Sprint won the contract. Network A is provided by AT&T and comprises 60% of the contract. Network B is provided by U.S. Sprint and consists of 40% of the FTS 2000 network. AT&T will supply network A services to over 1,100 locations supporting 58 agencies and handling 14 million monthly calls. U.S. Sprint will serve over 1,100 locations supporting 33 agencies carrying 10 million monthly calls. It is estimated that the FTS 2000 contract has a potential value of \$25 billion over its 10 year life [Ref.3 p.101]. It is estimated the military services will save 3% on their long distance phone bills which

will add up to millions in savings for each service. [Ref. 5: Conference]

B. FTS-2000 SERVICES

FTS 2000 will serve as the long distance carrier for all military services and major federal agencies. The network replaces the old analog system with digital system and the backbone of the network is fiber optic. Six types of services will be offered: Switched Voice, Switched Data, Packet Switched, Dedicated Transmission, Video Transmission, and Switched Digital Integrated Service.

1. Switched Voice Service (SVS)

FTS 2000 provides up to 4.6 kbps voiceband data. Types of SVS supports on-net, virtual on-net, and off-net configurations. SVS features include:

- * Agency Recorded Message Announcements
- * Attendant Services
- * Authorization Codes
- * Call Screening
- * Class of Service and Restrictions
- * Class of Service Override
 - Traveling Classmark
 - Code Block
 - Off-Net Information
 - Network Audio Conferencing
- * Translation

--On-Net and off-net

--Off-Net Translation

* Inward Station Access

* Inward Selected Access

2. Switched Data Services (SDS)

This service will provide dedicated, synchronous, full duplex, totally digital communications capabilities. This service will support workstations, host computers, personal computers, terminals, and other office equipment. Service delivery will be through dedicated access to data terminal equipment or indirectly through a PBX. Type 1 service delivery will use the EIA RS-449 standard for physical and functional interfaces and the RS-423 and RS-422 standards for electrical interface. Type 2 service delivery will follow the CCITT V.35 recommendation for physical, functional and electrical interfaces. Type 1 & 2 will transfer data at 56K and 64Kbps. [Ref. 3:p. 104]

3. Packet Switched Service (PSS)

Packet Switched Service may be used either by a dial-up line at 300, 1200 and 2400 bps or by a dedicated access line at 4.8 kbs and 9.6 Kbps and 56k/64Kbps. PSS will follow the CCITT X.25 recommendations. E-mail service may be provided on top of PSS. E-Mail standards will be fully compatible with CCITT X.400, X.401, X.409, X.411, and X.420 recommendations. [Ref. 3:p. 106]

4. Dedicated Transmission service (DTS)

DTS will provide point-to-point analog, digital and T-1 transmission service. Voice and analog data rates between FTS 2000 locations can be up to 9.6 kbps. The digital data service rate will be 9.6 kbps and 56-64 kbps. Dedicated, non-channelized T-1 transmission transport will be provided between FTS 2000 locations. The T-1 service uses the Extended Superframe Format (ESF).

5. Video Transmission Service (VTS)

VTS will support compressed and wideband video. Codec will be provided to ensure compatibility and promote interconnectivity with FTS 2000 locations. The wideband video signal will have a 6 Mhz bandwidth standard baseband

6. Switched Digital Integrated service (SDIS)

SDIS will fully integrate voice, data, image and video services through digital FTS 2000 user connectivity. ISDN and T1 digital interfaces are provided to support this service. SDIS will provide access to ISDN basic and primary rate interface structures. The basic rate interface structure will feature 2B+D channels, i.e., 2 64-Kbps and 1 16-Kbps signalling channel. Primary rate services will be provided by SDIS at 1.544 Mbps at the CCITT defined T reference point for ISDN. PRI service will provide 64 Kbps user transparent service in 23 bearer channels. T1 interfaces will include type 1 and type 2 (standard bit PCM and low bit PCM). Type 1 will

provide 24 channels. Type 2 will provide 44-48 switched voice or data channels. [Ref. 3:p. 105]

C. FTS 2000 LINKAGE WITH SX-200D DPBX

The capability exists for the SX-200D DPBX to receive T1 service and subsequent FTS 2000 Switched Digital Integrated Services (SDIS). The following additional equipment must be added to the system in order to interface with SDIS:

- * Superset 4 DN Console Part # 9184-000-210-NA
- * Digital Line Card with 12 ports Part # 9109-021-000-SA)
- * T1 Card: 24 Channels Part # 9109-21000 Clock Module Stratum 3 T-1 Part # 9109-060-000-SA

V. SUMMARY AND RECOMMENDATIONS

A. SUMMARY

When procuring telecommunication systems, it is imperative to work closely with the user. By understanding the user's requirements, the communication consultant can begin to design the system that will satisfy those requirements. Continuing to work closely with the staff personnel towards understanding the problems with the current telephone system and by surveying users to understand their requirements, the consultant can further define the objectives of the user and specify more accurately the required system capabilities. The next step, once agreement is made concerning the requirement specifications, is to develop the RFP. This document serves as a process and a tool for acquiring the needed products and services. The RFP should provide the prospective contractor with the necessary details of the desired telecommunication system and services required. If the RFP is written effectively, users have a better chance of receiving what they want. The next step is to evaluate vendor proposals. This process is the key ingredient next to the careful system selections. The methods suggested in this thesis for the purpose of evaluating vendor responses to the RFP include a Life Cycle Analysis, Net Present Value, and Total System Effectiveness determination.

Using one methodology exclusively over another (i.e., looking at life cycle analysis alone) could bias the evaluator into thinking there exists a clear cut choice between different vendors. The purpose of the evaluation process is to systematically review all the objective information that could otherwise go unnoticed. Once all the necessary steps have been taken towards systematically evaluating the vendors proposals, an overall weighting scheme should be developed. The objective of the evaluation is to select the most cost effective proposal.

B. RECOMMENDATIONS

The techniques for evaluating proposals discussed in this thesis can be applied to any product evaluation. It is the opinion of the author that the application of these techniques in evaluating proposals is essential for effective screening of large amounts of information that would otherwise have gone unnoticed. Complex evaluations could be completed by an evaluation team who objectively applies the techniques discussed in this thesis.

The possible linkage with the FTS 2000 indicates that the technology is now available to provide a wide array of communication services. With the MITEL DPBX system, services such as ISDN can be received with minimal modifications as described in Chapter IV. Prices for these services are currently being developed. Whether the BOQ will benefit from the Switched Voice Service has not been determined. The question remains as to whether the BOQ will be able to reduce phone costs as a result of using FTS 2000. Since the BOQ will fall under non-mandatory FTS 2000

requirements, due to its status as a hotel/motel operation, the BOQ will have the option to subscribe to FTS 2000 services. Another factor to consider is whether the additional services offered will be used by the BOQ and what value will be assigned to these services. These are areas for further research.

APPENDIX A GOVERNMENT-OWNED EQUIPMENT

The SX-200D DPBX equipment has been inventoried as follows:

<u>DESCRIPTION/STOCK NUMBER</u>	<u>QUANTITY</u>
(1) Main Control. Stock # 9109-036-000-NA	1
(2) Cabinet. Stock # 9108-000-001-01	1
(3) Bay Card. Stock #9109-017-010-NA	1
(4) ONS Line 12 CCT. Stock #9109-010-000-NA	9
(5) Disc Drive. Stock # 9109-124-000-NA	1
(6) LG/LS Trunk. Stock #9109-011-000-NA	2
(7) Bay PSU. Stock # 9109-008-000-NA	3
(8) SX-200 LCD Console. Stock #9108-007-001-NA	1
(Rev.A)	
(9) Control Key Model PL-150, Call Acctg. System. Serial #087128130-2C	1
(10) ONS Line 12CCT. Stock #9109-005-ONS LINE	1
(11) Various Operating Manuals for SX-200D.	9
(12) Generic 1001 Decryption Module.	1

APPENDIX B

**GOVERNMENT COST ESTIMATE FOR THE
TELECOMMUNICATION SYSTEM
AT BACHELOR OFFICER QUARTERS
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA**

LABOR:

1.	Installation: 220 hours @ \$90/hr (Includes cable, conduit, wiring, telephone and equipment installation, integration of switch, wiring and all equipment and peripherals)	\$19,800
2.	Engineering: 120 hours @ \$120/hr , (Includes cable, splicing)	\$14,400
	Total Labor:	<u>\$34,200</u>

EQUIPMENT:

1. Single line instruments w/message
waiting indicators (DTMF)
150 instruments x \$30.00 each \$4,500

2. Connecting Blocks:
4 pr Surface Mount, 66M1-50
4 pr Flush Mount, 66M1-100 \$110

3. Cable:
From Bldg 220>221 375 FT (200 pr) \$XXXXXX
 \$ x.xx X 375 ft
Laying Cable in Airborne Asbestos Environment \$XXXXXX
From Bldg 220>222 375 FT (200 pr) \$XXXXXX

 \$ x.xx X 375 ft
Laying Cable in Airborne Asbestos Environment \$XXXXXX

4. VOICE MAIL/AUTO ATTENDANT SYSTEM:
(10 hours message capacity with growth \$XXXXXX
capability to 40 hours)

5. VOICE MAIL SOFTWARE: \$XXXXXX

6. SOFTWARE UPGRADE TO GENERIC 1003 SOFTWARE

W/ 2 MEG MEMORY MODULE:

PART # 9109-518-300-SA

7. FLOPPY DISC DRIVE: \$XXXX

8. INTERFACE PORTS: \$XXXX

9. LASER PRINTER: \$XXXX

Total Equipment \$XXXX

Overhead (25%): (Total Equipment Cost) \$XXXX

Profit (10%): (Total Labor) \$XXXX

Total: \$XXXX

APPENDIX C

SCHEDULE OF COSTS FOR SUPPLIES/SERVICES

Enter prices for all items in the "Unit Price" and "Amount" columns of this SECTION B. If an item is offered at no charge, enter "N/C". DO NOT LEAVE BLANK. If the price is included in another contract line item number (CLIN), enter "NSP" and explain where priced. Failure to follow these instructions may render the offeror unacceptable.

INSTALLATION:

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>QNTY</u>	<u>UNIT</u>	<u>PRICE</u>	<u>AMOUNT</u>
01	Connecting Blocks, 4 pr Surface Mount	150	EA	\$_____	\$_____
02	Connecting Blocks, 4 pr Flush Mount	150	EA	\$_____	\$_____
03	SX-200 LCD Console Stock #9108-007-001-NA	1	EA	\$_____	\$_____
04	VOICE MAIL/AUTO ATTENDANT (Voice Mail System)	1	EA	\$_____	\$_____

05	VOICE MAIL SOFTWARE		EA	\$_____	\$_____
06	Software Upgrade	1	EA	\$_____	\$_____
	Generic 1003				
	Software w/ 2 MEG				
	Memory Module				
	Stock #9109-518-300-SA				
07	Floppy disc drive	1	EA	\$_____	\$_____
	(if needed)				
08	Interface Ports	2	EA	\$_____	\$_____
	Control Over Voice				
	(COV Cards) (if needed)				
09	Laser Printer	1	EA	\$_____	\$_____
10	Provide voice mail	200	EA	\$_____	\$_____
	user guides				
11	Single Line Instru-	140	HR	\$_____	\$_____
	ments w/ Message				
	Indicator Light				
12	Single Line Speaker-	10	HR	\$_____	\$_____
	phone w/ Message Ind-				
	icator Light				
13	Outside Cable Between	375 FT	HR	\$_____	\$_____
	Bldgs. and Terminate				
	Bldg 220 > 221 (200 pr)				
	Bldg 220 > 222 (200 pr)	375 FT	HR	\$_____	\$_____
14	Conduit Between Bldgs.				
	From Basement Bldg				

	220 >222 2 inch	175 FT	\$_____	\$_____
	plus 4 inch PVC	30 FT	\$_____	\$_____
15	Terminal Blocks	30 EA	\$_____	\$_____
	66M1-50			

TOTAL: \$_____

If necessary add the following items:

- Dual Common Control Panel
- Dual Ringing and Tone Generator w/Automatic
- Switchover
- Toll Restriction
- Paging Adaptor Circuit
- Visual Occupancy Room Status
- Automatic Wakeup Service
- Message Waiting Lamp Indicator
- Toll and Non-Toll Charge System
- Detailed Summary Report
- Station Message Detail Record (SMDR)

TRAINING:

16	General User Training	\$_____
17	System Training	\$_____
18	Automated Billing System Training	\$_____
19	Voice Mail and Auto-Attendant Training	\$_____

LIST OF REFERENCES

1. Datapro Management of Telecommunications, Report MT40-120, Evaluating Responses to Requests for Proposals, McGraw-Hill, Inc., Delran, N.J., January 1990.
2. Datapro Management of Telecommunications, Report MT40-100, Acquiring New Telecommunications Systems: Preparation, RFP, and Evaluation, McGraw-Hill, Inc., Delran, N.J., February 1989.
3. Datapro Management of Telecommunications, Report MT10-420, FTS 2000 Network, McGraw-Hill, Inc., Delran, N.J., January 1990.
4. Fritz, J.B., Telecommunication System for Bachelor Officers Quarters: Cost-Effectiveness and Lease/Purchase Analysis, M.S. THESIS, Naval Postgraduate School, Monterey, CA June 1990.
5. Presentation by C. Byard of COMNAVCOMTELCOM at the FTS 2000 Conference, held in San Diego CA, on February 20, 1991.
6. Datapro Management of Telecommunications, Report MT10-400, Federal Government Networking, McGraw-Hill, Inc., Delran, N.J., July 1988.